Effects of the second-generation larch plantations on soil fertility and tree growth

Wang Peihua (王培华)
Yichun Forestry School of Heilongjiang Province, Yichun 153000, P.R. China
Xi Suhua (席苏桦)
Forestry Bureau of Huanan County of Heilongjiang Province, Huanan 154400, P.R. China
Jiang Wenjuan (姜文娟)
Nongjiang Farm of Heilongjiang Province, Nongjiang 156335, P.R. China
Liu Yabin (刘亚彬) Sun Yuying (孙玉英)
First Planning and Design institute of Forestry Inventory of Heilongjiang Province, Mudanjiang 157011, P. R. China

Abstract In order to realize the effect of second generation of larch plantations on soil fertility and tree growth and to provide the theoretical base and the reasonable management measures, the growth of larch plantations for different generations at different soil conditions were inventoried and compared. The relationship between soil nutrition and tree growth of the second-generation larch plantations was analyzed. Comparing with the first generation, the second generation of larch did not present acidation phenomenon on the dark brown soil. With respect to the organic matter, rapidly available K and N, the values of the second-generation larch is close to that of first generation at later time. Platform-preparation is good measures for improving soil conditions
Key words: Larch plantation, Second generation, Soil fertility, Growth, Standing trees

Larch is one of the most important plantation species in the northeast region of China. After clear cutting of larch plantations it is the urgent problem to be solved that whether the second generation is continuously planted, whether the soil fertility is decreasing and the plantation is how to be managed on the forestry production. In order to realize the second generation of larch plantations and to provide the theoretical base and the reasonable management measures, we inventoried the growth of larch plantations for different soils and studied the relationship between soil nutrition and tree growth of the second generation for larch plantations.

Sites

One study site was chosen at 22# subcompartment of 60# compartment on Mengjiagang Forest Farm of Huanan County in Heilongjiang Province, with flat topography, typical dark brown soil and meadow brown soil. Two sites were selected in Dailing Forestry Bureau of Heilongjiang Province. One is at southwest slope of Donshan mountain, with a slope of 7° and typical dark brown soil, and the other is at 5 km of Songqing, which is hilly land with typical dark brown soil. In Magu Forest Farm of Fusun of Liaoning Province, two sites were set. One is at Salugou, with a slope of 15°, on southern slope and the soil of the area is brown soil, and the other is at Fangshengou, with a slope of 30°, on southern slope and the soil is brown soil. All about stands are all first, second generations of larch plantations at the same site.

Methods

Collections of standard plot

Totally, 28 temporary plots and contrast plots as well were set up. All standard plots were distributed at the same age, same density and similar site condition for the first and second generations of larch plantations. The height and diameter at breast height were measured. A stem analysis tree was cut at each plot. To further study, the materials concerning forest inventory and forest resources file of Huanian Forestry Bureau in Heilongjiang Province, Dailing Forestry Bureau in Heilongjiang Province and Fusun Mineral Bureau in Liaoning Province were collected.

Measurements of soil chemical factors

The pH value was measured by using a 25-type acidometer. Semimicro Kjeldahl method, H_2SO_4-$HCLO_4$-molybdennum antimony resisting colorimery method and AAS (atomic absorption spectrometry) method were adopted for measuring Total N, Total P

*Wang Peihua, female, born in May 1966, lecture, Yichun Forestry School, Heilongjiang Province
Received: 1999-11-12
Responsible editor: Chai Ruihai

and Total K respectively. Organic matter was measured with potassium dichromate method. Alkali solution diffusing method was used to measure the rapidly available N and 0.05MHCL-0.025MH_2SO_4 extracting method were used to rapidly available P. Rapidly available Ca, Mg, Cu, Zn, Fe and Mn were measured with AAS of P-E5000 type.

Results and analysis

Growth situation of different generations of larch

Growth of larch plantations at different site conditions for different generations is presented in Table 1. The growth showed a decrease after the second generation, but it was not the same for different site conditions. For good site condition, there was no obvious difference in DBH growth between the first generation and the second generation. Height growth was very different for various site conditions. Sometimes current annual increment (CAI) of DBH and height of the second generation was higher than that of the first generation, especially for height growth. This indicates that if the soil condition can meet the need of tree growth, tree can grows rapidly no matter what it is the first or the second generation

Soil fertility makes different effect on tree growth such as height growth and volume increment. It is obviously different for DBH growth. *q*-test showed that the effects of site conditions on the growth of height, DBH and volume were obviously different (see Table 2).

Table 1. Growth comparison of larch plantations at different site conditions for different generations

Site class	Age	Generations	Increment of Diameter/ cm			Increment of height /m			Increment of volume/ m^3		
			TI	CAI	MAI	TI	CAI	MAI	TI	CAI	MAI
I	5	1	2.3	0.46	0.46	4.3	0.86	0.86	0.00115	0.00023	0.00023
		2	2.9	0.58	0.58	3.0	0.60	0.60	0.00172	0.00034	0.00034
	15	1	10.9	0.72	0.73	13.6	0.94	0.91	0.06004	0.00859	0.0040
		2	11.9	0.66	0.79	12.9	0.66	0.86	0.06049	0.00750	0.00403
	25	1	15.4	0.34	0.62	20.3	0.54	0.81	0.1996	0.01432	0.00798
		2	15.7	0.30	0.63	19.4	0.60	0.78	0.1809	0.01380	0.00724
II	5	1	2.9	0.58	0.58	3.6	0.72	0.72	0.0017	0.000340	0.00034
		2	0.3	0.06	0.06	2.07	0.41	0.41	0.00002	0.000004	0.000004
	15	1	10.7	1.12	0.71	11.6	0.80	0.77	0.0496	0.00880	0.00331
		2	8.4	0.34	0.56	11.2	0.52	0.75	0.0347	0.00400	0.00231
	25	1	16.7	0.48	0.67	17.6	0.45	0.70	0.1895	0.01472	0.00758
		2	13.2	0.26	0.54	14.9	0.22	0.60	0.1088	0.00550	0.00435
III	5	1	5.2	1.04	1.04	3.6	0.72	0.72	0.00551	0.00110	0.00110
		2	0.7	0.14	0.14	1.88	0.38	0.38	0.0001	0.00002	0.00002
	15	1	10.3	0.6	0.69	11.6	0.80	0.77	0.05416	0.00671	0.00361
		2	8.7	0.58	0.58	8.6	0.73	0.57	0.02730	0.00390	0.00180
	25	1	15.1	0.46	0.60	17.2	0.46	0.69	0.1476	0.01019	0.00591
		2	11.7	0.28	0.47	12.6	0.36	0.50	0.0781	0.00500	0.00310

Note: 1) For site classes: a)I: Site is at back, middle or lower of hill. Slope is less than 20°. Thickness of soil horizon is more than 30 cm; b)Site between I and III; c)III: Site is at face, middle or upper of hill. Slope is more than 20°. Thickness of soil horizon is less than 30 cm; d) Site is at Magu Forest Farm of Fushun in Liaoning Province.

2) D=DBH, H=height, V=volume, TI=total increment, CAI=current annual increment, MAI=mean annual increment

Table 2. Variance analysis of 1st and 2nd generation of larch (20 years) for different site conditions

Site	Height /m					DBH /cm					Volume /m^3				
	I	II	III	T	X	I	II	III	T	X	I	II	III	T	X
1st	18.30	16.81	13.81	48.92	16.31	19.50	14.60	11.92	46.02	15.34	0.262	0.158	0.081	0.502	0.167
2nd	17.39	14.93	11.62	43.94	14.72	16.70	12.80	10.28	39.78	13.26	0.190	0.099	0.054	0.343	0.114
T	35.69	31.74	25.43	92.86		36.20	27.40	22.20	85.80		0.452	0.257	0.135	0.844	
X	17.85	15.87	12.72			18.10	13.70	11.10			0.226	0.128	0.068		
Deviation	0.91	1.88	2.19			2.8	1.8	1.64			0.073	0.059	0.027		

Note: T, X are the algebraic sum and mean of different generations and different site conditions respectively.

Soil nutrition of Larch of different generations

According to the results of data analysis, the soil nutrition of larch of different generations is presented in Table 3. From Table 3, we see that there are no

obvious difference on pH value, total N and microelement Fe among 3 forest types. There is no obvious difference on total P, organic matter, microelement Cu, Fe and Cu between the first and second generation. Comparing with the first and second generation, rapidly available N, total N, total P, and organic matter of coniferous broad-leaved mixed forest increase obviously. Rapidly available P and microelement decrease obviously. Comparing with the first generation and coniferous broad-leaved mixed forest, rapidly available P, microelement Zn and Ca increase obviously.

Table 3. Soil nutrition of larch of different generations

Forest Type	pH value	RA N /ug · g^{-1}	RA P /ug · g^{-1}	RA K /ug · g^{-1}	Total N (%)	Total P (%)	Total K (%)	Organic matter (%)	Cu /ug · g^{-1}	Fe /ug · g^{-1}	Zn /ug · g^{-1}	Ca /ug · g^{-1}
1st	5.25	621.94	31.95	155.70	0.30	0.13	3.99	8.93	56.75	4.62	156.13	1.93
2nd	5.60	517.92	72.74	123.60	0.27	0.12	3.99	8.73	55.01	4.38	203.67	2.04
CBMF	5.05	1311.73	10.91	140.20	0.75	0.20	3.99	13.30	65.26	4.57	150.25	1.06

Note: 1) Data is collected from A+Bhorizon; 2) Site is at Songqing Forest Farm of Dailing Forestry Bureau in Heilongjiang Province; 3) RA= rapidly available; 4) CBMF=coniferous broad-leaved mixed forest.

Recovery of land capability after clearcutting

In order to study the soil swampy after clearcutting and to improve generate, since 1986, we made a test the preparation of soil with high platform at Mengjiagang Forest Farm of Huanan County in Heilongjiang Province. The density of plantation is 5000 trees/hm^2. The distance of platform between rows is 1.5m. After position determent of soil platform, first cutting sod and loosing it with the spade, then digging soil and upsetting it on the platform, the high platform of 100cm×50cm×20cm is formed.

By observation there are some advantages as flowing for the preparation of soil: increasing temperature (see Table 4); increasing fertility; increasing perviousness; resisting drought; resisting flood; increasing freeze; increasing the increment of yang trees.

Table 4. Temperature changes for different mode of preparation of soil °C

Mode	Surface temperature	Temperature under 15 cm
Platform	23	21.5
Cavity	22	19.5
Contrast	20.5	20

Note: Site is at Mengjiagang Forest Farm of Huanan County in Heilongjiang Province.

Conclusions and suggestions

After clearcutting, it may plant the second generation of Larch plantation on rich soil or fertile soil. At beginning the second generation grows more slowly than the first generation but the former grows faster and faster late. Sometimes the current annual increment of the second is bigger than that of the first. The reason may be that in the process of clearcutting, it destroyed the ecological environment, so the soil lost the nutrition. After close of the second generation, land capability recovers slowly, the ecosystem is coming to be stable slowly and the capability resisting external condition increased.

Comparing with the first generation, the second generation of larch did not present acidation phenomenon on the dark brown soil. With respect to the organic matter, rapidly available K and N, the values of the second generation of larch is close to that of first generation at later time.

The reasonable mode of preparation of soil is the important measure of generation. The advantages of platform-preparation of soil can increase temperature, fertility and perviousness, make resistance to drought, flood and freeze and raise the increment of yang trees.

Acknowledgements

Data collection was help by Zhang Zhongshan, Yu Huachun, Ban Jiang, Zhu Yuanjin and Pan Jiangzhong. Authors thank for Prof. Li Changsheng for their helps in English.

References

Fang Qi. 1987. Effects of continued plating of Chinese fir on the fertility of soil and the growth of stands(in Chinese). Scientia Silvae Sinicae. **23**(4): 389-397

Liu Shirong, Li Chunyang. 1993. Nutrient cycling and stability of soil fertility in Larch plantation in the eastern part of Northeastern China (in Chinese). Journal of Northeast Forestry University, **21**(2): 19-24

Yang Yusheng, Qiu Renhui, Yu Xintuo *et al.* 1999. Nutrient elements biological cycle of undergrowth under different rotations of continuosly planting Chinese fir (in Chinese). Journal of Northeast Forestry University. **27**(3): 26-30